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ABSTRACT

This report documents the efforts of 15 Michigan school districts to bring about long term changes and improvement in the way science is taught to elementary school students. Over a three year period encouraging results on several fronts were noted, among which were improvements in student learning; an increase in teachers' abilities, confidence, and commitment; and the development of school and district leadership strategies. The work of these districts has also yielded valuable lessons about the challenges and complexities of bringing about constructive, lasting change in science education. This report provides insight into what was accomplished, what support structures and processes helped the districts improve, and implications for districts, support agencies, and funders who are seeking to improve science education. Appendices include: background on system change; a 19-item bibliography; stages of system change; and the 15 Michigan school districts. (DDR)

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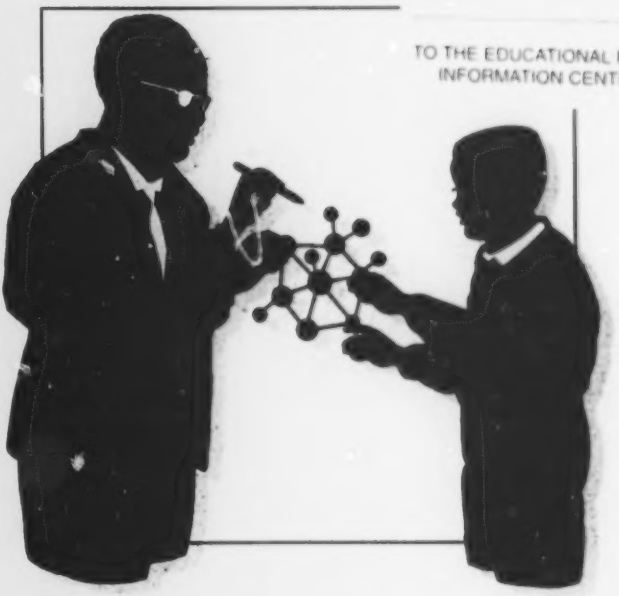

A REPORT ON SCIENCE EDUCATION IMPROVEMENT

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Celebrations & Challenges

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"If Little League groups taught baseball the way schools have traditionally taught science, kids would never actually get out on the field and play."

Introduction

If Little League groups taught baseball the way schools have traditionally taught science, kids would be given the rules and shown the mechanics of batting and throwing, but never allowed to actually get out on the field and play.

No wonder, then, that the watchword of the many promising new approaches to science education turning up all across the nation is: "Let the kids play."

From first-graders experimenting with hydroponics to high-school classes designing and building telescopes, more and more students are being given the chance to try their hand at the real work and the real rewards of science — inquiry, analysis, experimentation, and discovery.

This book documents the efforts of 15 Michigan school districts — supported by grants from Michigan's philanthropic W.K. Kellogg Foundation — to bring about long-term changes and improvement in the way science is taught to elementary-school students.

As you will see, the work of these districts over a three year period produced encouraging results on several fronts: improvements in student learning; an increase in teachers' abilities, confidence, and commitment; and the development of school and district leadership strategies to continue to improve their instructional programs. The work of these districts has also yielded many valuable lessons about the challenges and complexities of bringing about constructive, lasting change in science education.

The Science Improvement Cluster, as this 15-district effort was called, was one of three clusters under the Kellogg Foundation's Science Education Initiative — a funding effort. The remaining two clusters focused on collaborative, comprehensive approaches

involving post-secondary institutions and business support and on model science education programs in local schools.[1]

For the Science Improvement Cluster, the Foundation sought out school districts in Michigan — with limited funds allocated to science and typically left behind in times of change — to apply for grants to improve the schools' elementary-school science programs. The three-year grants, awarded in late 1992, ranged from about $23,000 to $115,000, for a total of $1.2 million.

Of the 15 districts that received grants:

- Six were rural (with student populations under 1,000).

- Seven were small, urban districts (with 3,500 students).

- Two were moderately large urban districts (with student populations of about 30,000).

While these 15 districts were in varying states of readiness to move ahead with comprehensive improvements in their science education programs, the districts had several things in common. In each district, there were educators who were dedicated to improving science learning. But in most cases, educators were strikingly out of touch with sources of new ideas and new methods, and/or were experiencing a feeling of helplessness about how to bring about change.

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[1] *The Foundation has completed its funded research in science education.*

This book provides insight into what was accomplished, what support structures and processes helped these districts improve, and implications for districts, support agencies, and funders who are seeking to improve science education.

The map that follows shows the names and locations of the 15 districts that were involved in the Science Improvement Cluster:

The 15 Michigan School Districts

"The districts showed improvement in three areas: teacher learning, student learning, and leadership."

Accomplishments

There were three major areas of improvement in the 15 districts: teacher learning, student learning, and leadership.

Improved Teacher Learning

After discussing the science issues, the districts recognized that a major reason students were not learning science was that teachers were inadequately prepared to teach science and did not teach science on a regular basis. It was assumed that student learning and interest couldn't improve until teachers became more comfortable with and knowledgeable about science. Then student learning and interest would follow. The major emphasis of the grant supporting change, therefore, was on helping teachers change what they taught, how they taught, and how they assessed student learning.

What they taught. In all of the districts, work was done to establish a curriculum based on the Michigan Department of Education's Essential Goals and Objectives for Science and aligned with the Michigan Education Assessment Program (MEAP). As a result, changes were made in what was taught and/or in the grade level certain topics were taught. In time, districts reported an increase in the relevancy of the content and learning process to students' lives. When students were engaged in activities such as building a nature trail and researching the information needed for trail signs, learning about soil conditions with the architects who were designing their school addition, and learning about measurement in the context of time spent in a medical center, they began to see science as meaningful to everyday life.

In Hamtramck, when the fourth- and fifth-grade textbooks were compared with the MEAP test, it was apparent that some topics tested on the MEAP were not being

taught until after the test was given. To solve this problem, units were switched around, so that the students were learning these topics before being tested.

In Vanderbilt, before the grant, science was not taught until the third grade. Now, students in lower elementary grades are tracking the North Pole expedition via the Internet.

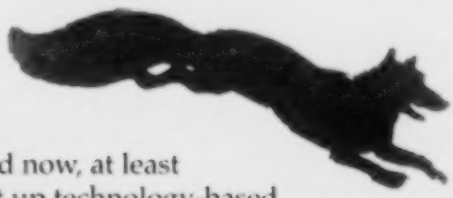
In Flint, a partnership with the McLaren Medical Center provided an opportunity for students to spend time with employees at all levels. Students connected their current school work with the real world by doing research on the Center departments they planned to visit — generating questions they would like answered. In addition, science units, including one on measurement, were developed. These can be used in the classroom and then applied in the Medical Center.

In Whitefish Township, the water life in a swampy area, a nature trail, and the Whitefish Point Bird Observatory provided knowledge about the natural world in the Upper Peninsula. As a result of these studies, students have become aware of the effects of pollution on their environment.

In Pickford, the forest served as a backdrop for environmental studies. Fourth-grade students did some forestry work on a nature trail under development. Second-grade students went on a fall gathering expedition.

How they taught. The emphasis in all of the districts was to move from a textbook approach to a hands-on, minds-on approach. The tendency was to first try hands-on activities since activities are readily available and students enjoy them. The districts were not as far along in moving to a "minds-on" approach, where conceptual understanding is expected.

Receiving funds to purchase equipment and establish lab space enabled districts to provide hands-on activities. Kits and materials, field trips, guest speakers, and community-based activities were needed to supplement the classroom work in many districts. And now, at least five of the districts have set up technology-based instruction by purchasing *Windows on Science*, a video disc-based curriculum. For some this was the primary curriculum, for others it was a supplement.



In Grand Rapids, a business partnership between one of the elementary schools and a local firm — Progressive Architects and Engineering — provided the opportunity for students to learn about soil testing and building design as the firm designed an addition to the school.

In Whitefish Township, "Windows on Science" was chosen as the primary science curriculum. Supplementing this were environmental activities, such as building a nature trail and using cross-country skis for winter nature studies.

Improved Student Learning

Changes in the state science test, shifts in how student learning was assessed, and informal teachers' reports were early indications of the impact of improvements on student learning.

Test scores. All districts showed increases in the percentage of fifth graders scoring in Category 4[2] on the science portion of the Michigan Education Assessment Program (MEAP). Even though these improvements cannot be attributed to this project necessarily, the districts were able to use these increases to encourage their staffs to continue to improve science education. (In several districts scores were so low that statistically an increase would be expected with little or no intervention.)

The MEAP scores were given in four categories, each category representing a percentage of students scoring in a quartile. The numbers in the table on the following page show the percentage of fifth-grade students in each district scoring in the satisfactory Category 4 (i.e., had 75% or more correct on the test) in the years indicated. The final column shows the changes from the 91-92 school year to the 94-95 school year.

How student learning was assessed. At the beginning of this project, most districts indicated that standardized tests (such as

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[2] *Category 4 refers to the students who scored in the fourth quartile, i.e., had 75% or more answers correct on the test. This is considered satisfactory.*

the California Achievement Test — CAT or Iowa Test of Basic Skills — ITBS) and teacher-administered tests were the primary ways districts assessed student learning. Over the period of the grant, the districts explored alternative assessment tools such as student portfolios, journals, and projects.

Grade 5 Science — Category 4 Achievement

	Year				
District	**1992**	**1993**	**1994**	**1995**	**+/-92-95**
Alanson	59.0	84.2	87.5	70.3	11.3
Covert	33.3	36.5	38.3	65.4	32.1
Ecorse	38.3	33.3	57.5	82.5	44.2
Fitzgerald	75.9	79.9	80.3	85.8	9.9
Flint (5th)	34.5	39.7	–	75.6	41.1
Flint (8th)*	20.9	37.2	–	61.8	40.9
Grand Rapids	52.8	51.6	53.0	57.1	4.3
Hamtramck	85.7	92.6	96.4	88.9	3.2
Ionia	68.5	70.3	78.4	77.3	8.8
Muskegon Heights	29.9	23.0	25.6	32.4	2.5
Oak Park	48.0	36.1	63.1	74.9	26.9
Pickford	56.7	72.4	81.3	65.0	8.3
Vanderbilt	62.1	66.7	72.7	66.7	4.6
Westwood	36.9	61.4	63.8	76.9	40.0
Whitefish Township**	–	33.3	77.8	–	27.8

* The projects in this cluster primarily involved elementary grades. In Flint, the project was a middle school project, so district scores are provided for the eighth grade as well.

** Whitefish Township did not have a fifth grade to test in 1992 or 1995. The change reported here is the change from 1993 to 1994.

Improved Leadership

Although these districts improved science education programs, these districts are still on the journey to long-lasting

systemic reform. A key part of continuing on this journey is leadership. The grants helped to position leaders who can work for system change. Project leaders were often teachers rather than administrators. The Kellogg grants provided these key personnel with considerable leadership experience in improving science education.

Development of leaders. In one district, the project was under way when a new elementary principal was hired. That principal then became a key person in encouraging teachers in this project. In two districts a new person was hired as the science specialist/coordinator and became the primary change agent for improvements in science. In the other 12 districts, existing personnel already were identified as leaders. Many of these key people were known for their positive reputations and connections within the district, and they used this influence to encourage and support teachers.

In Muskegon Heights, science coordinator Sue Syers used incentives and interpersonal skills to build positive connections with teachers. This increased their involvement in professional-development activities.

In Whitefish Township, fourth-grade teacher Gary Preston increased his own confidence by developing his technology skills. Then he took the lead in encouraging an Internet connection between the districts in the cluster.

In Fitzgerald, science coordinator Marilyn Bacyinski built on her experience and relationships within the district to encourage teachers to try new methods and activities.

In Ecorse, Arlester Carter rose to the challenge and increased his confidence in his role as science specialist. As a result, he increased his ability to influence other teachers to teach more hands-on science.

Long-term strategies established. Various strategies, implemented through the grant, have affected long-term changes. Five districts allocated funds to continue the science specialist position. Other districts emphasized adequate preparation of

elementary classroom teachers through continued professional development. One district will continue encouraging specialization of teachers in the third through fifth grades. In districts where the video disc-based science curriculum, *Windows on Science*, was purchased, the emphasis remained on continued training in the use of the technology in teaching science. As excitement built about science in several districts, interest grew in making changes in other curricular areas, and educators often adopted the model used in science.

"The synergy of actions taken by the schools and districts, roles played by the Foundation, and conditions in the state and nation account for the success of the project."

Success Factors

Several factors were related to the accomplishments previously described. These factors can be described in three categories: actions taken within the schools and districts, roles played by the W.K. Kellogg Foundation, and conditions within the state and nation.

Schools and Districts

Schools and districts used the grants to improve science education programs in 10 ways.

1. **Made science a priority.** School and district leaders repeatedly stated that, until receiving the Kellogg grant, science simply had not been a priority. In accepting the grant, leaders affirmed for teachers and the community that science was a priority area for improvement.

2. **Developed/purchased new curriculum materials, equipment, and facilities.** Districts had outdated curriculum materials and very limited equipment and facilities for teaching science. Nearly all used some of their funds to update curriculum materials, purchase new equipment (ranging from magnifying glasses and balances to computers and laser discs), and/or create a science room with lab tables and other basic facilities. Not only were these purchases essential to teaching hands-on science, they also signaled to teachers that the administration was serious about change.

One district updated the curriculum, going from textbooks so outdated that they refer to "man someday landing on the moon" to high-technology. The result was an increase in time spent teaching science, teachers with a renewed interest in science, and teachers talking to one another about science.

3. **Defined learning objectives for students.** All districts defined learning goals for students. The essential goals and objectives in science provided by the Michigan Department of Education guided this work.

In Oak Park, a new K-10 science curriculum aligned with the state's science goals and objectives was developed, and many kits and materials were purchased to support this new curriculum. Each of the four elementary schools in Oak Park developed a science room and identified a science management team responsible for organizing the room and the curriculum materials.

In the Fitzgerald district, a ninth-grade curriculum, "Ideas in Science," was developed and aligned with the state science objectives. Complete interdisciplinary course materials to support this curriculum were developed, including lesson plans, lab activities, and assessment instruments.

4. **Reconfigured how science was taught.** Four districts reconfigured the teaching of science. In two cases, a newly hired science specialist taught science and modeled science teaching for classroom teachers. In two districts, assignments among existing teachers were changed so teachers most interested in science were teaching all or most of the science to elementary students.

The Hamtramck district reorganized instruction in grades 3-5, empowering teachers whose primary focus is science. Teaching assignments were based on the strengths and interests of the teachers. Today, science is taught daily to upper elementary students. The result: increased student interest and decreased teacher apprehension about science education.

5. **Provided professional development for teachers.** All of the districts provided professional-development opportunities for teachers who teach science. In some districts, training involved all elementary school staff, and in others, only those at the grade levels involved in the project. Some made professional development a major priority early in the project while others came to see its importance after taking other actions. Five strategies for professional development emerged across the cluster:

   a. **Outside workshops.** Teachers attended outside workshops and brought back activities and methods to use in their

classrooms and schools. This strategy, focused on individual teachers, served three purposes:

- Expose isolated classroom teachers to new ideas in science education.
- Expose science teachers to new activities.
- Train certain teachers in topics they could teach to others in the district.

Outside workshops were most successful when:

- Workshops were focused on topics to be taught in the immediate future.
- Principals supported the teachers' use of the information.
- Teachers worked together following the workshop.

In Pickford, for the first time, all of the elementary teachers attended the Michigan Science Teachers Association (MSTA) conference because of the Kellogg funding. Networking with teachers from other districts and seeing the exhibits encouraged teachers and helped them solidify their knowledge of science reform in Michigan.

In Hamtramck, all science teachers involved in the Kellogg project attended the MSTA conference as well as workshops given by the Wayne County Regional Education Agency.

b. **District-tailored workshops.** Some districts had a specific series of workshops — tailored to their curricula -- which the districts expected and/or encouraged classroom teachers to attend.

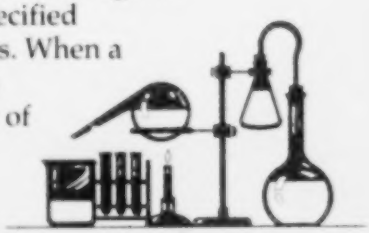
This approach was most successful when someone in the district was responsible for revising the curriculum and developing/scheduling workshops to correspond to the teaching schedule for particular units. The focus of the series and the approach used to involve teachers varied from district to district.

In Westwood, a four-week summer in-service trained four teachers as facilitators for school-year training of other teachers. This training provided teachers with information on new state requirements for science, science concepts, and alternative instructional approaches such as hands-on, minds-on, cooperative learning.

In Fitzgerald, an interdisciplinary course was developed for the ninth grade, and teachers, administrators, and counseling staff received an in-service on the course and its philosophy.

In Muskegon Heights, elementary-school teachers had opportunities to attend meetings on their grade-level science objectives, and the science coordinator personally encouraged them to attend workshops related to their objectives.

c. **Classroom modeling.** When a very structured approach was used, the science specialist, on a regular schedule, taught science in specified classrooms on identified topics. When a teacher-request approach was used, the teachers were aware of the availability of the science specialist, but teachers decided whether or not to request assistance.



Classroom modeling seemed to work best when:

- There was strong principal support.
- Teachers were encouraged and expected to involve the science specialist.
- There was a regular schedule for the specialist to teach in the classroom.
- Teachers were accountable for teaching science.

In Ionia, the Mobile Science Program provided elementary teachers with regular interaction with district science specialist Mark Hervey. Mr. Hervey traveled to the district's four elementary schools, spending one week per month in each school and teaching in each classroom in that school once during that week. He involved the students in hands-on activities or a lesson using laser disc technology. The teacher assisted him, learning new

instructional techniques as well as content. The activities were designed so that once teachers had assisted Mr. Hervey, they could teach the lesson the following year.

d. **Science room.** Two districts established a science room where a science specialist taught science to students brought there by the classroom teacher.

This strategy appeared to work best as an early strategy to expose teachers to science and hands-on activities. It did not work well as a professional-development strategy unless there was strong principal support and classroom teachers remained with the class and taught science in their classrooms.

In Ecorse, establishing a lab with a lab teacher "forced" science into the curriculum. A weekly time was scheduled for elementary teachers to bring their class to the lab, and the teachers were required to remain with their class. After the first year the district reported: "At the onset Mr. Carter [the lab teacher] did all of the hands-on activities, but toward the end of the semester the teachers were doing most of the hands-on activities." By the spring of 1995, the principal noted that the teachers were teaching science in their classrooms and taking their classes to the science lab even when the lab teacher was not available to assist them.

e. **Ripple strategy.** With this approach, all teachers were encouraged to attend any science workshops available. Teachers were expected to increase their science knowledge, obtain materials to use in their classrooms, generate excitement among teachers, and encourage other teachers to attend workshops.

This strategy seemed most effective when a single school with energetic leaders was involved. These leaders initiated the process and ensured that learnings were shared with others upon returning from workshops.

Vanderbilt, a small rural district, sent any willing and interested teachers to as many science workshops as possible. Five or six teachers took advantage of this during the first year of the project. Four teachers — an art teacher, a science teacher, and two elementary-school teachers — then took the lead in

encouraging the district's 21 teachers to consider thematic units. These units have become a major part of the realignment of their science curriculum.

6. **Provided assistance to teachers.** Teachers indicated that having a resource person was essential to adopting new curriculum units, hands-on activities, and new teaching strategies. Whether this was a science specialist or another teacher, teachers needed someone to turn to when they had difficulty implementing new activities and strategies.

7. **Provided administrative support.** Support of the school principal was also key. Supportive principals encouraged teachers and challenged them to try new methods and attend workshops. Principals also attended workshops with the teachers and encouraged community involvement.

In Pickford, Dan Barry became the elementary-school principal at the beginning of the grant period. His new assignment and the onset of the grant seemed to alert teachers and parents to the importance of science. Barry and several teachers worked together to develop science objectives, set up a parent-involved curriculum committee, make presentations to the board, and encourage new instructional techniques.

8. **Involved the community.** Although nearly all districts indicated that they were not yet satisfied with the level of community involvement, most reported strides in this area. Family science evenings — parents and students working on science activities together — and science fairs were the most popular approaches. A few districts generated business support to buy science equipment, and some developed partnerships that gave students opportunities to learn science in a real world context. Communication with the community occurred in some districts through newspaper articles, radio and TV appearances, and school newsletters. But districts still need parents and community members who are involved in decision making, curriculum revisions, and the establishment of strong business partnerships.

In Ionia, the district involved parents and the community in "telescope nights." During these evenings, families could use the school telescope (purchased by a local business) and discuss programs and events at the school. A community

dinner also was held each spring to showcase school activities. In recent years, attendance has increased — from low attendance to high attendance with up to 1,000 people.

In Covert, students developed over 160 projects for the first Covert Elementary School Science Fair. More than 130 people attended a K-5 fair with an even larger attendance the following year.

In Alanson, a group of mothers was active in the organization, Environmental Learning for the Future (ELF). The moms presented an environmental lesson in each elementary classroom once a month, often using materials from the school's science room.

9. **Linked science education changes to broader education changes in the district.** In a few districts, there was a growing emphasis on system change including changes in the bureaucracy of the district and in the nature of decision making. Science improvements was only one part of a broader change process.

   In Martin, with support from the superintendent, district leaders developed team structures and hired consultants to encourage change in developing student learning objectives, fostering new instructional approaches, and designing shared decision making. The goal was to redefine the district's "top-down" structure to one of greater ownership and involvement at all levels of the system.

10. **Built bridges.** From a long-term system change perspective, a key action of these relatively isolated districts was to build bridges with external groups that can continue to support the emphasis on science. Many teachers attended the Michigan Science Teachers Association (MSTA) conference where they were exposed to a wealth of materials and ideas about science teaching. Other teachers made connections with the state's Math and Science Centers or Intermediate School Districts (ISD) which provide for special needs across the districts. Although many connections have been made, there is still work to be done since extensive untapped resources are available.

The Pickford district made strong connections with its Intermediate School District (ISD) for professional development. The ISD also helped the district gain access to the Internet, thus increasing their class offerings.

In Muskegon Heights, the district, in collaboration with the Michigan Pine and Dune Girl Scouts Council, developed a Summer Sensations science program for girls. The district science committee is involved with a county-wide Science Curriculum Collaboration Project, affiliated with the ISD.

Foundation Roles

How did the Foundation encourage districts? District participants emphasized four key types of Foundation support which could be used by a funding agency with similar goals:

1. **Flexible but dedicated finances.** Most of these districts did not have community support for putting local funds into professional development and/or equipment. By having Foundation funds earmarked for science, districts were able to obtain essential professional development and equipment that could demonstrate the value of science. And, working with the Foundation project director, districts could modify initial ideas for using funds as understanding of science learning increased.

When all the elementary teachers in one district were planning to attend the MSTA conference, the board and community members asked: "Where in the world did you get the money and how could you possibly spend that kind of money on that trip?" When told it was from the Kellogg grant, responses changed to: "That's great." Even if there had been money in the district budget, community attitudes probably would not have allowed district funds to be spent on this valuable professional-development opportunity.

The curriculum director in one district said that the grant funding was "an awakening." Instead of selecting someone based on seniority, the grant monies allowed the district to hire a person with a science emphasis — someone who had the skills to work with teachers and the understanding of the curriculum that the district desired.

In Westwood, the Kellogg grant funds allowed for teacher professional development, hands-on science kits, and general curriculum improvements. This combination of actions yielded visible results.

2. **Credibility for establishing science as a priority.** Although each district had someone who believed in the importance of science, typically these individuals had been unable to convince others. The backing of the Foundation showed the community and teachers that science is important and gave credibility to an idea that previously had not rooted in the school and community.

3. **Networking conferences.** Each project year, district teams attended two or three conferences planned by Foundation staff and consultants. The purposes of these conferences reflected the expressed needs of the districts and those seen by the Foundation planning group. Networking was a primary purpose of every conference. The conferences gave the participants the opportunity to talk with people who were struggling with the same issues. Conference speakers also provided them new ideas on how to make science meaningful and how to bring about change in tradition-bound settings.

The networking conferences helped the Ecorse project team to build connections with other districts.

The science specialist and elementary principal from Ionia found the conferences to be very important as it was the place that "rekindled the fire about improving science."

Participants from Fitzgerald described the conferences as very energizing and important, because they were nonthreatening. There was exposure to new ideas and people, not a list of 100 things to do.

Several teachers emphasized the benefit of discovering what others were doing, explaining that the conferences had changed their orientations toward teaching — making them more hands-on.

4. **Supportive attitude.** Repeatedly, participants commented on the importance of the Foundation's attitude. All districts tended to lack confidence in their abilities to change, felt

inferior, and/or knew their performance was below par. At the networking conferences and through site visits, Foundation staff praised district accomplishments, expressed confidence in their abilities to improve, and trusted their judgment on ways to improve without expecting that everything would be done right the first time. Participants reported that this attitude was key in generating the confidence for them to move ahead.

A Vanderbilt teacher said the Kellogg grant gave the teachers a sense of self-pride, since the Foundation thought they were worthy of getting a grant.

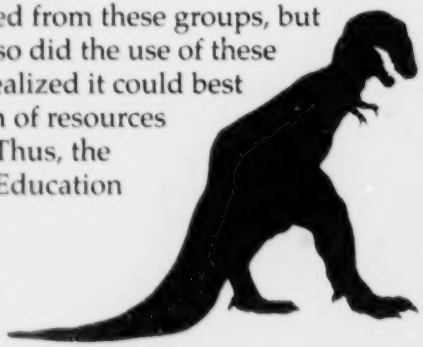
Conference participants indicated that Foundation staff did an excellent job of making people feel that what they were talking about and doing was worthwhile.

Policy and Resource Conditions

Districts like those in this cluster did not tend to be risktakers and trendsetters. Rather, these districts tended to wait until change was required and the paths to change were fairly well-established. The timing of these grants, converging with state and national policy trends, was excellent for these districts. Equally important, resources were available on a regional basis.

In-State Regional Support Groups

Several groups within Michigan provided professional development and other resources to districts on science-specific topics as well as broader issues of school reform. The districts in this cluster tended to be isolated from these groups, but as the districts' awareness grew, so did the use of these organizations. The Foundation realized it could best assist the sites by informing them of resources and how to gain access to them. Thus, the Foundation published a Science Education Resource Guide which included descriptions of over 20 groups involved in issues of curriculum, assessment, technology, and restructuring. The Intermediate School Districts (ISD), Math and Science Centers, local universities, and science networks such as MSTA, were among



the resources tapped for consultation, collaboration, and professional development.

State Policies

Two state policy conditions stood out:

1. **State framework of goals and objectives in science.** The state had recently established new goals and objectives in science that the districts were strongly encouraged to use in rethinking their science programs. Every district in this cluster used this framework to define its goals and objectives, even though some were initially concerned about feeling pressured. The districts continued with this framework, even though the state is wavering on its commitment to core curriculum objectives.

2. **Michigan Education Assessment Program (MEAP).** The state's assessment program was a factor in beginning this project as all districts in this cluster were selected because of low science scores on the MEAP. Although districts expressed concerns about the nature of the MEAP, nearly everyone found that it was a key motivation for change in each district, since state funding is now partially contingent on district MEAP results.

National Trends

Congruence with national trends to change the content and methods of teaching science increased each district's confidence.

1. **Meaningful science.** Science associations are leading a trend toward a science that is more meaningful to students and includes more hands-on teaching methods. This convergence of policy factors at both the state and national levels supported and motivated these districts in their science education improvement process.

2. **Internet access.** Another national trend that supported these districts is the growing accessibility of the Internet. This access resulted in a major addition to the work in a number of sites. The use of the Internet became significant in this cluster, because of the leadership of one teacher who learned how the

Internet could be used in science, demonstrated its use at one of the networking conferences, and encouraged others to become involved. Now, some districts are quite involved in using the Internet to augment their programs, where others are rapidly moving toward getting on the Internet, and several of these districts are using the Internet as a tool for continued interactions.

Supports To Be Developed

Through site visits and networking conferences, the districts were encouraged to use many individuals and groups to assist in their work. As districts continued to shape their science education programs and continued professional development for teachers, six types of support appeared especially important to develop:

1. **Change-facilitation teams.** Each site had a team, comprised of a teacher, a community member, and an administrator, who attended networking conferences and led the effort back home. Most had little training in how to work as a team and lead a change effort.

2. **ISDs and Math and Science Centers.** Although many ISDs and Math and Science Centers offered services such as leadership development, school restructuring, and strategic planning, many districts in this cluster only drew on these support agencies for teacher professional development. It is not clear whether the lack of use of ISDs and Math and Science Centers was because they were unaware of their other services, did not know how to gain access to them, did not recognize their significance, or other reasons.

3. **Networking.** Proactive networking appeared important to maintain support for continued improvement. While there was an increase in networking among teachers within districts as a result of this project, networking outside the districts seemed to be limited to the networking conferences and workshops which teachers attended through their ISDs

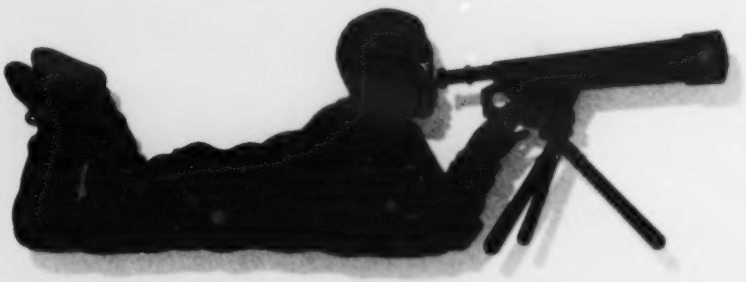
or other groups. A few contacts were made between cluster districts outside of the conferences, but more could be done in this area. Many of these districts seemed to be willing participants in programs offered, but took little initiative in making their own networking happen.

4. **External facilitators for planning.** In addition to ISD and Math and Science Center personnel, these districts often had access to local university staff or other trained people who could assist in planning and development activities. These are rich resources which these districts could profitably tap more in the future.

5. **Community**. To encourage communication and support for the changes being made in science, districts were required to have a community member on project teams. In some districts, this team member constituted the only involvement of the community, while other districts found creative and workable ways to actively involve the community. All the districts could gain from increasing community involvement at a decision-making level, from building partnerships with local businesses and industries, and from enlarging their views of the student-learning environment to include the community. Building these bridges, however, may be difficult, because there are few models for these relationships.

6. **Principal.** School principals' support varied. Some only tolerated the activities, while others actively led the process. In site visits and on questionnaires, teachers often commented on the value of support from their principals. This support could be fostered through professional development to increase principals' knowledge of current trends in science education and ways to support change.

"Most of the districts have a specific focus and a concrete plan to keep science a priority."



Future Directions

Most of the districts have a specific focus and a concrete plan for keeping science a priority in the district. Plans involve taking these actions.

1. **Increase professional development for teachers.** All of the districts saw a need to increase professional development opportunities. Plans included preparing a professional development strategy, increasing the professional development opportunities in science and in other areas (such as cooperative learning), and increasing the number of teachers involved in professional-development activities.

2. **Maintain the reconfigured program.** Most districts with newly hired science specialists intended to continue those positions with district funding. Hamtramck will continue its specializations among teachers in the upper-elementary grades.

3. **Change the hiring criteria for teachers.** Most elementary-school teachers in this cluster did not have sufficient background in science to feel comfortable teaching science. To strengthen their teaching staff, some districts will require that science teachers have science credentials or that new elementary-school teachers have strong science backgrounds.

4. **Encourage principal involvement.** Districts that recognized the importance of principal support were looking for ways to increase principal involvement. Professional development for administrators, having the science specialist meet with each principal to map a strategy for his/her school, and seeking alternative methods for teacher evaluation were ideas identified in these districts' plans.

5. **Increase use of technology.** To increase the use of technology, most districts will provide training in the use of various technologies and their applications in science.

6. **Seek other sources of funding.** Districts that could not continue funding their science specialist will look for alternative funding sources.

7. **Increase community involvement.** Many of the districts recognized that more could be done to involve the community but felt the districts needed to begin with curriculum and teaching changes. With those changes underway, the districts plan to increase the support and involvement of the community by:

   - Having parents and community members on science committees
   - Developing partnerships with local businesses
   - Adding a community-service component for students
   - Strengthening the connections between students and those in science careers

8. **Continue curriculum and unit development.** Several districts planned to continue developing and revising units and lessons to support the curriculum, expand the curriculum development to other grade levels or subject areas, and integrate science into other curricular areas.

9. **Continue work on alternative assessments.** Curriculum changes and state requirements for student portfolios drove the need for alternative assessments. During the project most districts only began to touch on the area of assessment and to see the need for further development in this area.

"While accomplishments are encouraging, system change is a much more complex and long-term process than is often realized."

Progress Toward System Change

While the accomplishments are indeed encouraging, it is important to consider whether these accomplishments are likely to support long-term improvement in science education.

Studies of how systems change are still in their infancy and new research is ongoing. (See Appendices A and B for further discussion of system change and recommended readings.) The evidence to date suggests that system change is a very complex and long-term process.

Research indicates that it takes 10 years or more to achieve the depth of change that is being sought in science education in these districts. The changes involve not only daily practices and habits but also major shifts in basic assumptions about teaching and learning and how people think about their roles.

For example, when seasoned teachers believe that the best way to teach is to closely follow a textbook and to have students in rows listening, it is not easy for these teachers to shift the focus of student studies to "hands-on" science and exploration of topics that arise from everyday experiences.

There are many definitions of system change and a variety of ways of considering the process. For the purpose of this evaluation, we have used a framework that emphasizes the stages that a school, district, and/or state education system goes through over time.[3]

Stages of System Change

Six stages of change characterize the shift from a traditional education system to one that emphasizes interconnectedness, active learning, shared decision making and higher levels of

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[3] *The information that follows is taken from Anderson (Parsons), B.L., "Stages of System Change," **Educational Leadership**, September 1993.*

achievement for all students. Change is unlikely to follow a linear path. An education system will seldom be clearly at one or another of these stages, but rather will go back and forth from one stage to another on the path toward an ideal situation. These six stages are:

Maintenance of the Old System. Educators focus on maintaining the system as originally designed. They do not recognize that the system is fundamentally out of sync with the conditions of today's world. New knowledge about teaching, learning, and organizational structures has not been incorporated into the existing structure.

Awareness. Multiple stakeholders become aware that the current system isn't working as well as it should, but they are unclear about what is needed to change it.

Exploration. Educators and policymakers study and visit places that are trying new approaches. These educators try new ways of teaching and managing, generally in low-risk situations.

Transitioning. The scales tip toward the new system as a critical number of opinion leaders and groups commit to the new system and take greater risks to make changes in crucial places.

Emergence of a New Infrastructure. Some elements of the system are operating in keeping with the desired new system, and these new approaches and structures are generally understood and accepted.

Predominance of the New Systems. The more powerful elements of the system are operating as defined by the new system. Key leaders begin to envision even better systems.

Key Elements of the Change Process

As schools, districts, and states move through the developmental stages just described, six elements of the education system seem to be particularly important in terms of monitoring and evaluating the change process. They are:

- Vision and leadership
- Public and political support
- Networking
- Teaching and learning changes
- Administrative roles and responsibilities
- Policy alignment

Making simultaneous changes in all six elements of the system requires conscious planning. The process is akin to remodeling a building while people are still using it. Redesign and reconfiguration must be carefully staged to keep the building functional. Appendix C contains a framework that gives more details about what to expect as these six elements move forward through the stages of change.

Let us now return to the accomplishments and supporting success factors presented earlier in the book and consider them from the perspective of the system change framework just outlined.

Progress of System Change in the Participating Districts

When the grants were awarded, most of the sites were in the *Maintenance* or early *Awareness* stage of change, with a few people or activities in the later *Awareness* or early *Exploration* stages. Over the course of this project, all sites moved to a more advanced stage of change, with some moving considerably farther than others and/or moving forward in a larger number of areas.

Generally speaking, by the end of the three years, at least a core group of people at each site had moved to the later *Awareness* or early *Exploration* stage. This is indeed significant progress, but it isn't sufficient to bring about lasting change. This is the point, in fact, at which many reforms derail; people get caught in an endless loop of exploration of new ideas, not fully committing to them. Or people are derailed by opposition for

which they are inadequately prepared. Consequently, it's easier to revert back to old ways of operating.

Based on our experience with reform in other situations, we believe that the successes achieved in the cluster districts are very fragile. The successes depend on whether principals and district administrators continue to keep science improvement as a high priority. All too often, once a project is over, administrators assume that the task has been accomplished and they can turn their attention to other things. Continued progress is also highly dependent on whether teachers and other leaders developed through the project continue in their positions. In at least two districts, the key person was close to retirement, and in a third district, the key person was taking a leave of absence to go to graduate school.

Much remains to be done to have fully functioning, high-quality science education programs in these districts. Let's look at the remaining work in terms of the six key elements of change mentioned previously.

Vision and Leadership

The vision that participants had for an education system and what it should accomplish had to change in order for the system to change. Through the various stages of development, the number of people from different groups who agreed on the shape and purpose of the new system increased.

All of the districts took a major step toward creating a vision of what science education should look like when they established science learning goals and objectives for students. However, in most cases, only a small portion of the people who needed to understand these goals and objectives — teachers, administrators, parents, and community members — were involved in developing them or had adequate opportunities to learn about them and understand their significance.

In terms of leadership, most project team members improved their skills in leading change. They gained considerable

confidence in their leadership ability, but most had a need for further learning in such areas as strategic planning, public engagement, data gathering and analysis, administrative practices, and how to maintain a systemic perspective.

Public and Political Support

As the vision developed and was translated into practice, the support of the public and of political leadership at all levels of the system had to grow. Such support involved a deepening of the "what" and "why" of the changes needed. The inclusion of diverse constituencies and populations appeared to be critical in building support.

Although all of the districts could point to things they did to involve the public and/or parents in the science program, nearly all districts expressed frustration and uncertainty about how to proceed in this area.

This calls attention to another critical aspect of the change process. Even if there is public support and involvement in a district, generating enthusiasm for a particular subject area is difficult. It's even harder when there is no tradition in place for this public participation.

In some of these districts, perhaps the school and/or district should rethink its overall philosophy (spoken or unspoken) about parental and public involvement. With that in mind, perhaps administrators could develop a strategy that builds on the work done through the science projects and then goes well beyond the confines of science.

Networking

Building networks that study, steer, and support the new vision is essential to establish lasting system change. These networks typically do not rely on the existing bureaucratic structure. Instead, they frequently use computers, newsletters, conferences, and personal communications to link people with similar roles across existing organizational lines.

Networking is typically the lifeblood of change, and districts needed strong support in this area. These sites made connections

through the networking conferences, participation in MSTA, and attendance at outside workshops. However, without support for change-facilitation teams and/or active encouragement from principals and district administrators, networking may wither and die.

Teaching and Learning Changes

Teaching and learning based on the best available research on how students learn is at the core of the new system. Closely related is the perspective that all students need to and can learn the higher-level skills of understanding, communication, problem solving, decision making, and teamwork. If changes do not occur in teaching and learning, all the other changes have little value.

As noted earlier, the major emphasis in most of the projects was on teachers' professional development, with considerable learning occurring for teachers. In most cases, those who are expected to teach science have considerable learning needs themselves.

Typically, it takes many years for teachers who have little or no preparation in science (or whose science learning has not been updated for 20 years) to become comfortable enough to teach science. And external groups must continue to keep the focus on science.

As a result, we believe continued professional development for teachers is essential in all these districts.

Administrative Roles and Responsibilities

To achieve change in the classroom, administrative roles and responsibilities must shift at the school, district, and state levels from a hierarchical structure of control to one of support and shared decision making.

There is a common pattern in the educational change process: teachers move forward with new ways of teaching only to find that their principals do not understand their new approaches and are holding them accountable for old ways of doing things. It is difficult to adhere to a new approach — even if you strongly

believe in it — if the people who evaluate you and determine your professional future have different sets of standards.

Only a few of the principals involved in this project were involved in learning about new ways of teaching science. If long-term change in science education is to occur, professional development for principals and other key administrators is needed in several areas, including: understanding new modes of teaching, the need for new scientific content, alternative modes of leadership, and how to involve external support agencies and people in the change process.

Policy Alignment

State and local policies must be aligned with the beliefs and practices of the new system, particularly in areas related to curriculum frameworks, instructional methods and materials, student assessment practices, resource allocation, and the inclusion of diverse students.

One key policy change was made in all of the districts — the adoption of new science learning goals and objectives. Other policy changes are still needed to reinforce and build on the accomplishments that were made in the course of the project.

For example, in a few districts, policies were changed (at least informally) so that newly hired teachers were required to be trained in teaching hands-on science. Other districts needed policy changes like this to create lasting changes. This probably means that school boards will need to be more involved in the science education improvement process to establish policies such as these for the longer term.

"The lessons learned are not final answers, but can lead to new horizons of system change."

Lessons Learned

You will undoubtedly see many different lessons to be learned through the Science Improvement Cluster. In this chapter, we have highlighted process and support lessons that helped these districts move toward long-term system change in science education. We do not view these lessons as final answers. Through additional work with districts or with other social systems besides education, we expect to confirm or modify the lessons that have surfaced through this cluster.

We've organized the learnings according to the audiences:

- Districts in the cluster or districts similar to them
- Agencies that provided support services to districts as they improved science education (ISDs, Math and Science Centers, etc.)
- Policy makers (legislators, school boards, etc.)
- Funders of education improvement

The lessons put the experiences of these sites in the context of existing research on system change. They emphasize the connections of the work conducted through the grants to other aspects of the districts' operations that are or will need to change to sustain the work of the projects.

Lessons for Districts

1. **Professional development plan.** All teachers, not just the ones most receptive to change, need an ongoing, long-term professional development plan. In most districts, only the most receptive teachers were significantly affected by the professional development. Teachers need ongoing professional development to make the new ways of teaching a dominant pattern throughout the schools and districts.

2. **Professional development for principals.** Principals must also learn how to support improved science education. In most districts, professional development focused only on teachers. There was greater success in the schools where the principals were involved, supportive, and understanding of the changes. Principals need an understanding of the processes of change as well as specifics about science education reform.

3. **Materials and equipment.** Investments in materials and equipment are more beneficial when linked to professional development and teacher input. Teachers were motivated to learn when they knew that the equipment they needed would be available to them. Also, when professional development was provided and teachers were involved in selection of materials and equipment, teachers were more likely to use the purchases.

4. **Change-facilitation team.** An ongoing change-facilitation team increases the likelihood that initial changes will have a lasting impact on the schools and district. Each district had a team composed of a teacher, administrator, and community member. Having teams rather than individuals working to change science education made the change more systemic (i.e., there was an impact on more aspects of the education system). The challenge for each district now is to continue (or reformulate) a team that will facilitate change as the district moves to new challenges in the change process.

Lessons for Support Agencies

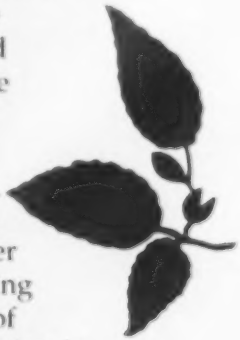
1. **Networks.** Strategically designed networks for teachers, administrators, and parents encourage new approaches to teaching and learning. Teachers, administrators, and parents/community members who participated in the networking conferences indicated that the conferences boosted their confidence in their ability to make change, gave them new ideas, and helped them build their own support structure with colleagues they met through the conferences. Likewise, the MSTA conferences gave teachers, who were typically isolated from national and statewide trends, an

opportunity to connect with others who were on a similar journey of change.

Characteristics of effective networks for these districts include:

- Participants have an ample opportunity for informal discussion.
- Networking events are abundant with mutual respect, trust, and encouragement.
- Participants both give and receive within the network.
- Information is specific to participants' situations.
- Participants make decisions whether to incorporate new ideas and approaches.

2. **Outside assistance.** Districts/schools were especially receptive to outside assistance when they were encouraged to take the lead in deciding what was best for their situations and when there was a climate of trust. A common point of appreciation among the participants was that the Foundation treated them with respect, assumed they were in the best position to decide what their goals should be, and trusted them to make good decisions and learn from the actions they took. This suggests that these same features will enhance the districts' receptivity to other outside assistance. Frequently low-performing districts are treated as if they are incapable of change or disinterested in change. In all districts in the cluster, we found people who were ready to step forward to lead change within a supportive environment.



3. **Packaged materials.** The districts/schools gravitated toward relatively packaged materials that they could adapt rather than developing their own. They were interested in materials that had been shown to work elsewhere. However, they needed time and support to undertake the adaptations. The adaptation process was often time-consuming and required

support from others who were familiar with the specifics of the materials as well as their situations.

4. **Assistance in planning and evaluation.** The districts tended to have weak or nonexistent processes for planning and evaluating major changes in teaching and learning. Those planning and evaluation mechanisms that were in place tended to be overly mechanistic or perceived as punitive rather than supportive.

Also, few of the districts in the cluster had existing change-facilitation teams who were charged with the responsibilities of improving education. And where these teams did exist, few had had training in how to facilitate change. Participants recognized the need for more opportunities to learn how to bring about change.

Lessons for Policy Makers

1. **Timing of policy actions.** Districts with limited resources devoted to change in a particular subject area (e.g., science) appear to succeed in their change process at a different time in the state or national policy cycle than innovative, resource-rich districts. Based on the experience of this cluster, change within districts with limited resources devoted to change happened more quickly and deeply when technical support structures were in place (e.g., the Math and Science Centers and ISDs) and after policies had been established that required and/or encouraged change in what students were to learn (in this case, the state science goals and objectives and the MEAP). Innovative districts, on the other hand, tended to flourish in their change processes during the early stages of the policy cycle — when new ideas were being tested and strategies of implementation were being developed.

2. **Targeted, but flexible funding.** The districts benefited from targeted, but flexible funding provided with a tenor of trust and support. (Frequently, low-performing districts are treated as if they are incapable or disinterested in change.) In all

districts in the cluster, we found people who were ready to step forward to lead change within a supportive environment. They were motivated by not only the opportunity to design their own goals for change, but also the flexibility to change their goals and approaches as they gained new knowledge and insights into the change process.

3. **Professional development for both teachers and administrators.** Districts needed professional development for both teachers and administrators. This cluster focused its attention on professional development for teachers. As work proceeded, the districts realized that professional development for principals and other administrators was essential if change was to be long lasting. Administrators needed to understand not only the essence of the changes being made in what and how teaching occurs, but also how to develop strategies for long-term change.

4. **Training, planning, and evaluation support long-lasting change.** Districts needed trained change-facilitation teams and supportive planning and evaluation processes to encourage long-lasting change. Making changes in what and how science is taught is not only a long-term process, but it also can create unexpected changes in other aspects of the curriculum, school structures (e.g., needing longer blocks of time to teach science), and connections with the community. A team (with representation from teachers, administrators, the community, and other role groups) responsible for planning and strategizing for long-term change is beneficial. These teams still need skills in how to undertake planning and evaluation in ways that encourage change rather than create fear.

Lessons for Funders

1. **Supportive networking conferences.** Using networking conferences and a cluster approach to funding enhanced the ability of these districts to change. The networking

conferences and supportive Foundation program directors were highly valued by the districts. The networking conferences gave participants the opportunity to talk with others who were struggling with low student performance, provided new ideas tailored to their situations, and helped them see the bigger context as they were attempting to make change. The program directors gave participants confidence in their ability to determine their needs and take action, as well as the flexibility to learn and grow in their decision making.

These aspects of the networking conferences seemed especially important to maintain:

- Time for informal as well as guided discussions on ways to improve learning for students
- Knowledgeable people to provide concrete examples of new modes of teaching and learning
- Time at each conference to reflect on progress and adjust plans for the future

2. **Strategically timed grantmaking.** Grantmaking designed for system change needs to be strategically timed to fit state and national policy cycles. As noted earlier, the timing of these grants was excellent for the districts in these ways:

   - The state had established new science goals and objectives and districts drew on these to shape their programs.
   - The state financing policy linked funding to the results of the state's student assessment program (encouraging attention to new modes of teaching and learning).
   - The state had established professional-development opportunities for districts.

   These policy conditions provided encouragement to districts that were not risk takers. To encourage changes in these types

of districts, proper timing is essential to capitalize on other forces that may be encouraging these districts to change.

However, if state and/or national policies are in the early stages of formulation, funders will probably have a stronger, systemic impact if they support organizations that can develop examples of new modes of operation or ones that would work out general strategies for change in policy areas.

3. **System change framework.** To strengthen their support of system change, funders should consider mapping their initiatives against a conceptual framework of system change. For more information, see Appendices A-C.

   With a conceptual framework of system change, funders can better connect initiatives and more strategically select the next intervention points in the system. This framework also can be used to help identify likely partners who could enhance the funders' impact.

4. **Strengthened technical assistance.** In addition to providing funds, funders may need to support technical assistance when working with districts with limited resources. The cluster was designed with consultants providing technical assistance for both program activities and program evaluation. In addition to technical assistance specific to teaching science, districts needed help formulating a planning and evaluation process for their situations and establishing the roles and responsibilities of a leadership team.

5. **Followup**. A mechanism for followup could help determine the extent to which district investment leads to long-term change. Although the grants were catalysts for change, considerable work remains before these districts have strong science education programs. Their change efforts are very fragile. Although we can

speculate about whether the change will continue, the best way to find out is to contact the districts in a year or two to determine what improvements have been maintained, what further improvements have been undertaken, and what their goals are for the future.

"The work in these districts has produced encouraging results. However, to achieve the desired depth of change, continual attention and effort will be required."

Summary

This book documents the efforts of a cluster of Michigan school districts — supported by grants from Michigan's philanthropic W.K. Kellogg Foundation — to bring about constructive, lasting changes and improvements in the way science is taught to elementary-school students.

Three-year grants, totaling $1.2 million, were awarded in 1992 to 15 districts on the basis of demonstrated need for, and commitment to, improving student learning in science. The districts were Alanson, Covert, Ecorse, Fitzgerald, Flint, Grand Rapids, Hamtramck, Ionia, Martin, Muskegon Heights, Oak Park, Pickford, Vanderbilt, Westwood, and Whitefish.

The work of these districts over the past three years has produced encouraging results in several areas: improved student achievement; an increase in teachers' abilities, confidence, and commitment; and the development of long-range strategies — at the school and district level — to continue to improve their science education programs. Among the signs of progress:

- All 15 districts established, or are in the process of establishing, science learning goals and objectives for students.
- All of the districts showed improved scores on the Michigan Education Assessment Program test.
- Districts created new opportunities for teachers to develop and expand their instructional and leadership skills and reconfigured the way science was taught, including hiring science specialists and resource coordinators.
- Districts significantly upgraded science curriculum materials, equipment, and facilities.
- Districts established stronger business and community support for and involvement in science education.

This book examines what was accomplished in the 15 districts, the support structures and processes that helped them improve, and the implications for funders, policymakers, and state/district support agencies.

The work of these districts yielded many valuable lessons about the challenges and complexities of bringing about comprehensive, long-term change and improvement. But to achieve the depth of science education change being sought in these districts, continued attention and effort is encouraged in the following areas:

- Strengthening professional-development opportunities for teachers and administrators
- Establishing a strong, stable core of leadership for change at the school and district level
- Supporting and expanding networks that create greater visibility for new approaches to teaching and learning and that allow educators, parents, and communities to share new ideas and new ways of doing things
- Providing technical assistance and training to schools and districts, particularly in the areas of planning, evaluation, and leading change efforts
- Creating a policy environment — at the state and district levels — that promotes and supports school-based innovation and improvement
- Creating a stronger sense of partnership among schools, districts, families, communities, employers, and support agencies

Appendix A
Background on System Change

Background on System Change[4]

Definitions of System Change

Different definitions exist for the term "system" or "system change." Here are five definitions to consider. If you're working on system change, we encourage you to develop your own definition. It's likely to include some or all of the following meanings.

Definition 1: Changing multiple parts of the system

One of the earliest notions of system change was that changing only one part of the system was inadequate. Many aspects of the system need to change. However, in the 80s and before, when such interventions were being attempted, specialists in each part of the system were working in their corners of the world with little concern or attention to what others were doing. Consequently, one change could just as easily cancel the positive effects of another.

Definition 2: Recognizing interconnections among parts of the system

Soon people realized that attention needed to be given to the interconnections among the parts of the system and the interactions among changes within those parts. In the late 80s when the term "system change" began to gain considerable popularity, the term was typically used to draw attention to the connections among the parts of the system.

Definition 3: Changing the fundamental design features of the system

Once the interconnections within the system were recognized, people moved to an even more significant meaning of system change. They realized that deep and often unrecognized principles, values, and beliefs define the system. If we are to have

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[4] *Adapted from InSites,* ***Analysis of System Change in Education and Human Services: Facilitators' Guide****, Ft. Collins, CO: InSites, 1995.*

significant change, these features must change. Here are some examples.

Examples:

What students should know and be able to do. When the current education system was established a century ago, people were primarily focused on having students gain very basic skills in reading, writing, and arithmetic, and basic knowledge in other areas. Although those things are still desired for students today, an additional level of learning is expected. Given the increasing complexity of society, people want students also to apply basic knowledge and skills to complex situations, to be decision makers and problem solvers able to gain access to information.

The role of students and teachers. Another example of the shift from the old system to the new system is how we view teaching and learning. When the education system was established, the main mode of teaching was delivery of information. If teachers stood up in front of the class and delivered information, we expected students to learn. But over the years, much research has been done on how people learn. Recent research shows that it requires a different type of learning for students to acquire the higher-level skills of application, integration of information, decision making, and complex problem solving. Students must interact with other people as well as with information. Students need projects where they are compiling information from many different sources and assessing how to apply that information in meaningful and practical situations. This approach to learning means that the teacher plays a very different role. He or she no longer stands up in front of the class, lecturing, but rather the teacher serves as a facilitator, coach, and guide to students as they work on projects and tasks collectively and individually.

Designing the system around learning instead of teaching. The following story illustrates this shift. One day a man was walking his dog down the street, and the man ran into his neighbor, Bill. "Guess what?" said the man. "I taught my dog how to talk!" "Well, that is just incredible," said Bill. "Have him say a few words." "Oh, I just *taught* him," stressed the man. "He didn't *learn*."

Similarly our education system has focused on teaching, rather than learning. As a result, another shift must be to design features of the system (e.g., accountability) around what students are to learn rather than around actions of the teachers.

Multidirectional information flow. Many of today's organizations are built on the factory model of organizations. In this model, people at the top do most of the thinking and pass down orders to the other people in the system. But, we've begun to realize that this system does not work for many of the tasks we need to accomplish. Our organizations are now becoming much "flatter," with people at all levels expected to think, integrate information, and accomplish tasks. Information does not flow only top to bottom, but in many different directions.

Definition 4: Processing Change

In the early 90s, this definition was enriched even further. As people realized how long it takes to fundamentally change a system, they began to look at the stages within the change process, leading to yet another dimension of system change. As an organization or system attempts to move away from one state of being to another, there are often six stages that occur:

Maintaining the Old System. The primary focus is on maintaining the system as originally designed. People assume that if they improve what they have always done, all will be well.

Awareness. Gradually people gain in awareness that they need to do different things, but they are not sure what to do.

Exploration. In this stage people try out new ways of doing things and look for the fundamental differences, patterns, actions, and ways of operating.

Transitioning. As these new fundamentals become clearer and people have good examples of doing things differently, they are ready to commit to a new way of doing business. Up until this point, people have been able to add on the new ways. Now, they cannot proceed without letting go of old ways that are counter to the new approaches. Unless people eliminate the old ways, they don't have the resources and energy to engage in the new ways for the long-term.

Emerging New Infrastructure. This occurs once these deep transitions take place. Others who may not have been willing to commit before this time are now convinced that this is the better way of doing things — or at least it is the one that will be rewarded and expected.

Predominance of the New Systems. At this stage, people never have the new system fully in place because as they approach their desired system they always see something beyond that is even more desirable.

This definition of system change is discussed in greater detail in later parts of this appendix.

Definition 5: Categories of Adopters

Another definition of system change focuses on the well-researched phenomenon that people have distinct responses to innovations. This definition derives largely from the research of Everett Rogers and has been accumulating for the last 30 some years (Rogers, 1995). He identifies five types of responses: (The numbers in parentheses indicate the typical percent of people that fall into each category relative to an innovation.)

Innovators. Innovators tend to be adventuresome, eager to try new ideas. These people are not troubled by setbacks or incomplete ideas or methods. Innovators tend to network quickly outside their local circles. (About 3%)

Early Adopters. Early adopters are more a part of the local social system and include local opinion leaders. These people are not as far ahead of the average individual as innovators and are locally trusted. (About 13%)

Early Majority. These people adopt new ideas just before the average person. They seldom hold leadership positions and tend to deliberate for quite some time before adopting an innovation. (About 34%)

Late Majority. These people adopt a new idea just after the average person. They often don't adopt ideas until there are economic necessities and growing peer pressure to do so. These

people tend to have few resources and want to be sure a new idea is well-developed before they risk change. (About 34%)

Laggards. Laggards are the last to adopt an innovation. They are not opinion leaders and tend to be isolated. They look to the past as a point of reference. (About 16%)

For large-scale system change to occur, nearly all of these categories of people need to be functioning under the mode of the new system.

Stages of System Change

As noted in the fourth definition of system change, as an organization or system attempts to move away from one state of being to another, there are often six definable and interactive stages that occur:

Stage One — Maintenance of the Old System

In this first stage, people try to improve what they were already doing. They tend to say, "Well we know that we could do this a little bit better. If we just try harder, I'm sure it will work." But soon people begin to realize there is something to that old adage: "If you always do what you've always done, you always get what you always got." Gradually they begin to realize they need to do something differently. At that point, people begin to move into the *Awareness* stage.

Stage Two — Awareness

In this stage people are becoming aware that what they have been doing is inadequate, and there must be something better. This is a rather frightening stage, because they recognize that they need to give up the familiar, and yet they don't know what it is they are supposed to do instead. Awareness creates not only fear, but also a sense of guilt and unhappiness with how they have performed in the past. Guilt and blaming often characterize this stage. For example, as teachers learn that there are other teaching strategies that could be used, they feel that they have been a failure or have damaged children all these years by having taught in ways that were not the most effective. In other cases, people start blaming other people. Teachers blame the administration,

the administration and the public blame teachers, and the teachers blame students and parents.

After a while, however, people realize that finger pointing and guilt are not going to get them very far, and they move on to attending to alternative practices. As people hear about new ways of doing things, they become more open to the possibility of actually changing. This leads into the *Exploration* stage.

Stage Three — Exploration

In this stage, people discern new ideas from many sources. Exploration takes a number of different forms. One is to visit other schools and communities to see what these new practices look like. Simply talking about the new ideas is often insufficient; people need to actually see the practices in operation either by visiting schools or communities or at least viewing videotapes of new practices. Visits are especially helpful, because people can talk to their colleagues and learn more how practices have changed. Visits also give teachers an opportunity to ask the questions that are important to them.

Another type of exploration is to set up study groups within the school or community. The study groups identify and read articles on new practices and then discuss what they have read and consider how it applies to their situations.

These conversations are extremely important both at the *Awareness* and the *Exploration* stages. They illustrate that interaction among people is the way we learn (whether adults or children), and that adults need time to talk with others to change their mental images and models of good teaching, administration, or other practices. The ground rules of effective dialogue become particularly important here (see Senge, 1990).

Another key activity at the *Exploration* stage is for people — at all parts of the system — to actually try some new approaches. The idea is to get different approaches springing up among those who are interested in trying new things. Some teachers may be exploring cooperative learning; others may be involved in site-based management approaches; others may be looking at different ways of engaging students in conducting projects; and still others may try performance assessment, involving projects

and portfolios instead of multiple-choice tests. The idea in this stage is for people to understand practice at a deeper level and how practice works in their situations.

A couple of precautions during this stage: a common problem is that people latch onto one technique — thinking it will solve the problems of the system. They often become strong advocates for this technique and criticize others for not using it. This undermines the environment of trust and encouragement for learning that is essential to move forward. Another problem that can occur is that people try so many things and keep hearing about still more new ideas that practices are tested at a very superficial level.

As people progress through the *Exploration* stage, they often reach a point where they feel overwhelmed and can't put everything together. They do not know how to make choices. These people try to choose a single technique — missing that there are fundamental themes running through many of the approaches. People must learn to ferret out the themes and common assumptions that will give them a basis for designing a new system.

For example, teachers using cooperative learning may realize that students develop jointly shared solutions to problems. These solutions are better than those students would have developed individually. Similarly, a principal involved in site-based management may find that decisions are being made that are better, because teachers who have a deeper understanding of events in the classroom are involved. Teachers are also more committed to solutions they understand, because these teachers have developed the solutions.

As this stage progresses, people look more deeply at the commonalties promising practices share — reviewing fundamentals that should be viewed as characteristics of the new system.

Stage Four — Transitioning

At this stage, people are beginning to make a commitment to some new practices. Up to this point, people have been able to try

out new things **and** keep doing the old things. If critics become concerned about the new practices, the reformers can lean back on the old approaches. However, in the *Transitioning* stage, people begin to realize they can't keep doing both. Up to this point, it has been relatively easy to keep adding new practices. It's likely that a few teachers or others in the system have been willing to put in the extra time (probably with little pay) to try something new.

However, it's clear this cannot continue. Some past practices must be eliminated, because they cannot afford both and because this sends mixed messages. As a result, the *Transitioning* stage is characterized by hard decisions. It also involves budget reallocation and personnel decisions.

Stage Five — Emerging New Infrastructure

In this stage, people begin to make real commitments to new practices. The commitment has been made when new teachers or administrators are hired based on criteria that support the new ways of operating. Another outward sign of commitment is when resources are allocated to support new practices, rather than maintain the old way of doing business. For example, schools allocate resources based on student results, instead of traditional budget categories. When a state or district is in the *Emerging New Infrastructure* stage, about 20 percent to 30 percent of schools or districts usually are committed to using new practices and policies.

Stage Six — Predominance of the New Systems

In this stage people move closer and closer to a vision of the new system, but begin to see a vision beyond it that they decide is even better. People tend to see based on their current knowledge. When they get closer to the vision, they see something on the horizon that seems even more intriguing and appropriate.

It is unrealistic to expect that everyone will have adopted the "new system," as defined. A state is at this stage when about 65 percent to 85 percent of communities are operating according to the definition of the new system.

A continually evolving picture of the desired new system probably will be with us for our life-times. We are in such a

rapidly changing period of history that change is something we need to become accustomed to. We can't expect to get everything revamped and then sit back and coast. This is an ever-changing landscape.

Participants in System Change[5]

Although there are a number of ways one could group the participants of the system, we have chosen to look at two collective units and five roles played by individuals. These units and roles probably will remain, despite the design and desired results of the system.

The two collective units of the system are:

- system leadership
- school

The individual units within the system are:

- students
- teachers
- administrators
- policymakers
- parents/community

Here is a brief description of these individual and collective system participants and how they tend to move through the stages of system change. The descriptions draw on an extensive body of research. (See attached reference list.) The descriptions assume that people are moving toward a system defined by characteristics most commonly promoted by national school reformers.

Collective Units of the System

The nature of the leadership of the system and the norms of the school and community are key elements to track in the process of system change.

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5 *"Participants in System Change" represents an alternative way of looking at system change (in contrast to "Elements of System Change" used throughout this book).*

System Leadership. A key to system change is how the leadership evolves and changes as the system changes. Simply, the evolution of leadership from the typical old education system to the new one(s) is characterized by a shift **from**:

- Heavy hierarchy and bureaucracy **to** shared and distributed leadership throughout the systems
- One way communication **to** multidirectional communication with extensive use of networks and partnerships
- Large top-down organizations **to** smaller partnered and networked organizations
- Decision making detached from the student "customer" **to** decision making open to and connected with the customer
- A focus on inputs and activities **to** a focus on results
- A focus on the past **to** being guided by a vision of the future

Schools. Extensive research shows that although individuals must change, there is a shared set of implicit or explicit norms that shape individual change. These norms tend to be defined within a school or community. Thus, one needs to look at change within the norms of the school and community. As they shift from old systems to new ones, the school/community progress tends to be characterized by a shift **from**:

- Repeating patterns of the past **to** consciously looking at past patterns and making judgments as to whether these patterns should continue
- A focus on the past **to** a focus on the future
- A focus on problems and weaknesses **to** a focus on strengths, assets, and possibilities
- Little attention on results for the students **to** major attention on how the system has an impact on student results

Individual Units in the System

We can group individuals within the education system by the roles these individuals play.

Students. How students perceive their relationships to the system are key aspects of system change — and aspects often overlooked. Students are frequently seen as passive recipients rather than active participants in the shaping and functioning of the system. In fact, this is the dominant change that occurs in the shift from the old system to the new system — students shift **from** being passive and powerless **to** being actively involved participants with power to influence the system and with responsibility for achieving the results they desire and the results the system is designed to support.

Teachers. Teachers have the most direct contact with the system's customers. How teachers function and view their roles and responsibilities has major impacts on whether and how systems change. Teachers undergo a shift **from**:

- Delivering information or services **to** a role as coach, mentor, and supporter of the students' learning and growth
- Assuming responsibility for following rules and regulations **to** assuming responsibility for supporting the accomplishment of the desired results of the system
- Viewing themselves as authorities **to** viewing themselves as partners with students and communities in the accomplishment of results
- Viewing their responsibilities as part of a narrow specialty **to** seeing themselves as partners with other service providers in helping students have an holistic view
- Having limited access to information **to** having broad access to information

Administrators. The new system tends to be characterized by a different type of administration than the old system.

Administrative functions, as well as the administrators, change. Administration moves **from** a fairly passive role of ensuring that rules and regulations made by policy makers are followed **to** ensuring that desired results are achieved by system customers. For example, resource allocation decisions may be made by teachers at the community or school level rather than higher in the system. Those decisions are driven by what will achieve desired results, leaving considerable flexibility for teachers, communities, and schools to decide the best ways to achieve results. Accountability systems under the new system are also focused on results, leaving considerable flexibility for local people to determine the methods to be used to achieve those results.

Administrators also shift from a focus on protecting turf and resources to working in partnership with others to use their collective resources and power bases to serve the customer. Administrators thinking systemically while acting locally look at short-term and long-term impacts and how actions taken for one purpose can have an impact on other parts of the system.

Who carries out administrative functions is also likely to change. Instead of a few people with only administrative responsibilities, administrative tasks are likely to be distributed among several people. For example, teachers may have a specific amount of time designated for administrative functions, thus reducing the distance between service and administration.

Policy. Policies establish the broad framework and parameters of how a system functions and what it is intended to accomplish. The process of policy making shifts from the old system to the new system in several ways. For example, policy shifts **from**:

- Being driven by bureaucratic convenience and maintenance **to** achieving desired results
- Being segmented and uncoordinated across systems **to** being coordinated and systemic
- A heavy emphasis on mandates **to** strategic use of incentives and waivers as well as mandates

- State or federal policy being highly directive **to** state and federal policy setting broader parameters within which effective local policy can be made
- A focus on compliance with rules and regulations **to** a focus on results

Parents/community. The role of parents and community also changes from the old system to the new. The old system tends to be closed to public influence with the major mode of public influence being the election of people for various policy positions. The new systems are much more open, with significant public involvement in shaping the desired results of the system and the modes of operation that best fit the needs and values of the community. The new system is much more accountable for keeping the public informed of its operation and accomplishments.

Patterns within the Change Process

As these groups move through the stages of change, it is important that they are moving forward. Imagine that rubber bands are connecting the various parties. If the rubber bands are stretched too far, they break.

On the other hand, there must be some pioneers — within and across groups — who help propel the system forward. An ongoing dynamic needs to be created throughout the system. There is no one right way to move the system toward the new configuration. Policies, schools, communities, or others may lead. The trick is to keep deepening the dialogue within and among groups to improve the quality of implementation of changes and to clarify the basic principles upon which the new system rests.

Appendix B
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Appendix C
Indicators of Progress on System Change

Stages of Change

Elements of Change	Maintenance of Old System	Awareness	Exploring
Vision	Vision reflects: • Learning based on seat time • Teaching as lecture • Mandates and inputs • Education system separate from social service systems	• Multiple stakeholders realize need to change • Strategic plans call for fundamental changes	• Stakeholder groups promote new ideas for parts of system • New examples debated • Growing numbers and types of stakeholders drawn together
Public & Political Support	• Support taken for granted • Only a concern when finances are needed • Public informed, not engaged	• Policymakers, media discuss need for changes • Public forums on change	• Task forces formed • Leaders speak on key issues • Minor resource allocations • Public involved in defining learning outcomes
Networking	• Networking seen as insignificant • Partnerships are one-shot, supplemental	• Networking valued • A critical mass of teachers in a school explore joining networks • Realization that partnerships need to be longer-term, integral	• Networks (including electronic) share information • Schools, districts, and states join networks • School leaders contact potential partners
Teaching & Learning Changes	Emphasis on: • Standard curriculum • Delivery of information • Standardizing tests • Raising scores	• Recognition that current research is not used in teaching, and that education problems are due to broad social, economic, technological changes	• Resources committed to learning new teaching methods; multi-year commitments • New modes of assessment explored • Outcomes are defined
Administrative Roles & Responsibilities	Responsibilities seen as: • Diminishing conflict • Emphasizing standardization, rules • Providing information • Top-down decision making	• Administrators recognize need to change roles • New roles, responsibilities discussed • Media attention on innovative leaders	• Site based decision making piloted • Professional development for administrators focuses on new roles • Bureaucracy questioned • Some resources allocated to learning outcomes
Policy Alignment	Policy emphasizes: • Textbook selection • Standardized teaching, tests • Comparisons among schools on student achievement • Hierarchical structure	• Experimentation promoted • Recognition that standardized tests don't measure all learning outcomes; low achievement may be due to conditions beyond teaching	• New assessments explored • Policies defining graduation based on demonstrated learning piloted • Curricula emphasize higher learning for all

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Stages of Change

Transitioning	Emerging New Infrastructure	Predominance of New System	Elements of Change
• Emerging consensus • Old components shed • Need for linkages understood	• Vision includes student outcomes, system structure, underlying beliefs • Continual refinement of vision, expanded involvement	• Belief that all students can learn at higher levels • Learning means achieving and applying knowledge • Education connected to social service	**Vision**
• Public debate • Leaders campaign for change • Resistant groups vocal • More resources allocated • Diversity recognized	• Ongoing task forces • Resources are ongoing; emphasis on meeting diverse student needs • Public engaged in change	• Public, political, business involvement essential • Allocation of resources based on new vision	**Public & Political Support**
• Networks recognized as long-term features • Debates on how to support ongoing networks • Disenfranchised groups use networks for empowerment	• Networks accepted practice; major source of new knowledge • Empowerment issues debated • Multiple partners support vision	• Resources allocated for networks • Networks serve as major communication channels • Power is shared	**Networking**
• Teachers, schools, districts try new approaches • Teachers given time to plan • Recognition of change needed and resources required • Teachers convinced it's not a fad • Changes assessed	• Assessments encourage improvement, recognize uneven progress • Graduation based on outcomes • Teaching engages students • Ongoing teacher development	In most schools: • Student learning is active • Assessments are focused on outcomes • Teacher and administrator preparation uses outcomes	**Teaching & Learning Changes**
• Methods developed to distribute decision making • Emphasis on outcomes to be achieved • Resources for ongoing teacher professional development	• Administrators hired using new criteria • Site-based decision making • School-community councils • Teachers responsible for instructional decisions	Administrators: • Encourage rethinking, improvement • Allocate resources to support student learning • Use site-based management	**Administrative Roles & Responsibilities**
• Task forces define student learning outcomes • Schools have latitude to redesign teaching and learning approaches • Recognition that policies need review	• Exit learning outcomes developed, emphasize complex learning • Multiple means of assessment • Major review of policy • Education and social service policies connected	Policy supports: • Ongoing improvement • High student standards • Learning outcomes • Flexible instruction • Alternative assessment	**Policy Alignment**

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Appendix D
The 15 Michigan School Districts

The 15 Michigan Districts

Alanson Public Schools

Covert Public Schools

Ecorse Public Schools

Fitzgerald Public Schools

Flint Community Schools

Grand Rapids Public Schools

Hamtramck Public Schools

Ionia Public Schools

Martin Public Schools

Muskegon Heights Public Schools

Oak Park Public Schools

Pickford Public Schools

Vanderbilt Area Schools

Westwood Community Schools

Whitefish Township Schools

Appendix E
Acknowledgments

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Appendix F
Further Information

Further Information

For further information about science education changes in the 15 districts, contact the superintendent of the district. The district names are listed in Appendix D of this book.

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